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Test Standard for Joist Connectors Attached to Cold-formed Steel Framing

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Test Standard for Joist Connectors Attached to Cold-Formed Steel Framing

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Abstract

Recently the America Iron and Steel Institute (AISI) developed a new test standard for testing joist connectors attached to cold-formed steel framing. This test standard will provide designers, manufacturers, and researchers with a consistent methodology to determine load ratings for these types of commonly used connectors. Often these connectors have a composition or configuration such that calculation of their structural capacities cannot be made in accordance with the provisions of the specification. This standard has been submitted to the American National Standards Institute (ANSI) for approval as an American National Standard (ANS).

Introduction

It is common in cold-formed steel construction to use a joist hanger, clip or angle to connect two structural members. The composition or configuration is commonly such that calculation of their structural capacities cannot be made in accordance with the provisions of the specification. The purpose of this test procedure is to establish test requirements for these connectors used in cold-formed steel light-framed construction. Also, it provides guidance for determining allowable stress design (ASD) and load and resistance factor design (LRFD) design loads for cold-formed steel connectors as well as deflection service limit loads for the connectors.

The scope of the document limits the application to connectors which are primarily resisting a shear reaction. Axial, bending and torsional loads, such as where the joist is unrestrained by bracing, are outside the scope of the document.

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Description of the Test Standard

The test standard developed is based on similar test standards developed for similar types of products in wood construction; specifically ASTM D1761 and ASTM D7147. Also, the International Code Council Evaluation Service (ICC-ES) has created an acceptance criteria for connectors used with cold-formed steel structural members, AC261, which is similar in content. It is anticipated that once the subject test standard is approved, it will be submitted to ICC-ES for consideration.

It should be noted that hold-down connectors are covered by the newly drafted AISI *Test Procedure for Hold-Downs Attached to Cold-Formed Steel Structural Framing*. Having different test standards recognizes and separates the important differences in performance requirements between different types of connectors

The test standard document is divided into sections to describe the test fixture, test specimens, test setup, test procedure, data evaluation, and test report.

1. Test Fixture

Typically hydraulic or screw operated testing machines are used to perform these types of tests. A picture of this type of device is shown in Figure 1. The equipment needs to be capable of operating so that it is applying a controlled constant rate of loading. Load cells are used to measure the magnitude of the applied load. They are available in various sizes capable of measuring different magnitudes of load. The test equipment should also include deflection measuring devices which are capable of reading to 0.001 inch (0.025 mm). The test setup and measuring devices shall be such load and deflection characteristics of the connector are recorded during the test. This will facilitate the development of a load-deflection curve.

2. Test Specimen

The test specimen includes the connector to be tested as well as the fasteners used to install the connector in making the connection. The standard requires that the fastening methods and techniques used with the connection shall be done in a manner representative of actual field conditions. Also, the steel properties, including yield strength, tensile strength, percent elongation and uncoated base steel thickness, of the tested connector used in the test assembly shall be determined. This information will be then used to adjust the results of the testing per Section F1 of AISI S100 to account for material over-strength and over-thickness.

3. Test Setup

The test setup description covers the cold-formed steel joists, supporting members and connector to be investigated. The specimen shall be representative of field conditions. The standard provides guidance on how the setup shall be constructed so that unintentional load paths are avoided. It also discusses where the deflection measuring devices shall be located. Reinforcing of the joist members is permitted to prevent member failure away from the connector. Figure 2 shows a side view and top view of the test set-up. The side view is included in the test standard.

Often the greatest challenge in these tests is creating a test setup which accurately portrays field performance. For example, Figure 3 shows a test setup with a load transfer block is fastened to the side of the joist. This enables the load to be applied in the vertical shear axis of the member. Figure 4 shows the loaded joist which is loaded in the plan of the vertical shear axis and, as a result, not showing signs of torsional warping.

4. Test Procedures

When testing a specimen a preload not exceeding 10 percent of the average ultimate load is permitted. This preload will effectively set the joist in the seat of the hanger. The justification for preloading the connector is that after installation there will be some initial load during the construction process that will effectively seat the joist in the hanger. If the specimen is not preloaded it is possible it will reach the established deflection limit prematurely. During testing the load shall be applied at a uniform rate between 0.03 and 0.10 in. (0.76 to 2.54 mm) per minute. As noted earlier, the load-deflection characteristics shall be recorded to create of a load-deflection curve. The standard assigns a deflection limit of 1/8 in. (3.2mm), unless justified otherwise.

5. Data Evaluations

The standard does not include specific guidance to how the results shall be evaluated and the available strength of the connector determined. Rather, it refers the user to Section F1 of AISI S100.

6. Test Report

The test report shall include information necessary to provide insight to the end user. This includes a description of the test specimen, steel mechanical

properties, modifications made to the joists, load rate, location of displacement information, maximum test load values, and the load-deflection curve.

Conclusion

This new test standard will provide designers, manufacturers, and researchers with a consistent methodology to determine load ratings for joist hangers and similar devices attached to cold-formed steel framing. These connectors have a composition or configuration such that calculation of their structural capacities cannot be made in accordance with the provisions of the AISI NAS S100 specification. Establishing a standardized test fixture, setup, procedure, report and evaluation enables a consistent exchange of information needed to reliably communicate and understand the behavior of the connector.

References

American Iron and Steel Institute (2007), *North American Specification for the Design of Cold-Formed Steel Structural Members, S100-07*, Washington D.C.

American Iron and Steel Institute (2007), *North American Standard for Cold-Formed Steel Framing – Floor and Roof System Design, S210-07*, Washington D.C.

ASTM International, D1761-88(2000), Standard Test Method for Mechanical Fasteners in Wood, West Conshohocken, PA

ASTM International, D7147-05, Standard Specification for Testing and Establishing Allowable Loads of Joist Hangers, West Conshohocken, PA

International Code Council Evaluation Service, *AC261, Acceptance Criteria for Connectors used with Cold-formed Steel Structural Members* (approved October 2004, editorially revised January 2008), Whittier, CA.

Appendix

Figure 1: Picture of a typical testing frame

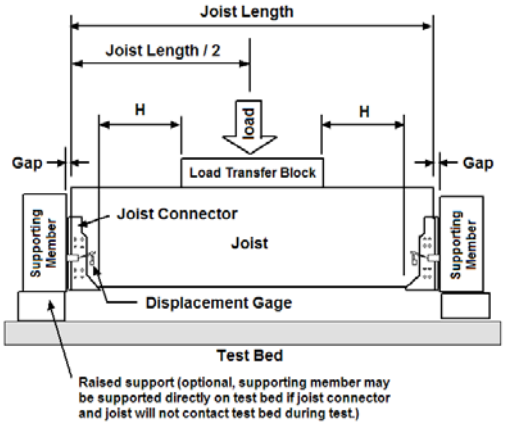

Figure 2: Test Set-up for Joist Connector

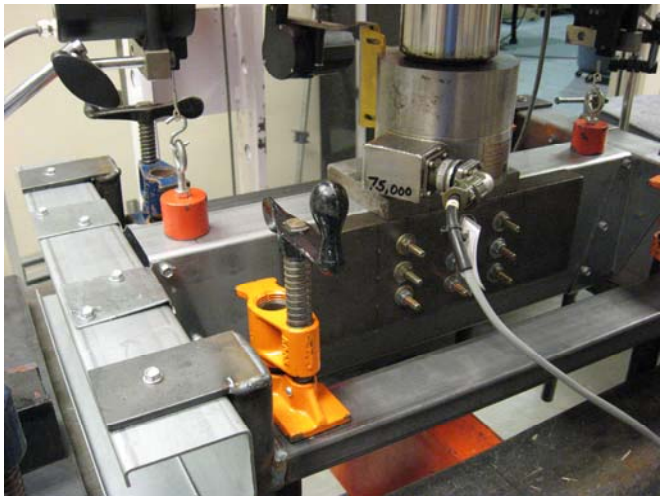

Figure 3: Load Transfer Block Attached to Joist

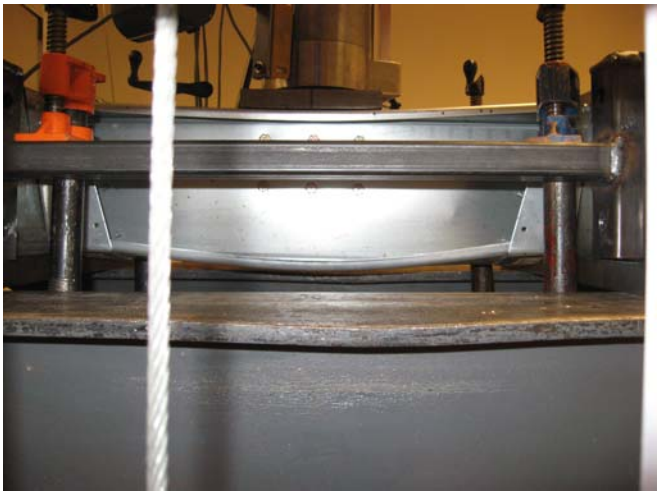

Figure 4: Deflected Joist Loaded Through the Vertical Shear Axis